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ABSTRACT

Individual differences in perceptual information processing were tested using 327 ten year old children, with verbal tasks representing successive information processing and spatial tasks representing simultaneous information processing. Three sets of tasks, (1) visual/reconstruction (V/R), (2) visual/verbal (V/VL), and (3) verbal/reconstruction (VL/R), were used to assess the interaction of verbal and spatial information processing. Significant spatial verbal interaction was obtained for V/VL and VL/R sets of tasks. Verbal coding of simultaneous information posed more difficulty for the subjects than non-verbal coding of verbal information. (STS)

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Perceptual Information Processing as a Function of Spatial and Verbal Individual Differences[1]

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Perceptual Information Processing as a Function of Spatial and Verbal Individual Differences

Human variability is a reality, which is not to be ignored or deplored, but rather to be understood, recognized, valued, and employed in the service of mankind. This diversity is a fact of life inherent in the very structure of the present society. "The choice we have is whether to play up this fact or to play it down, to welcome differences or to accept them grudgingly. To follow the latter course in a mistaken quest for equality is to lose our best hope for the future of mankind (Tyler, 1974, p. 7)."

A considerable amount of activity began in the early part of this century to study and measure individual differences. Earlier attempts were primarily concerned with the assessment of intelligence. It was not until the World War II era that attention was directed to specific abilities, traits, and styles. Both hierarchical and multifactor conceptualizations in mental measurement acknolwedged the existence of verbal and nonverbal abilities. Some early theorists considered these abilities to be distinct and functionally independent. It was not until the clinical, neuro-psychological and physiological research on brain lesions was carried out that the functional integration of the brain processes underlying the verbal and nonverbal abilities was recognized. The present paper will deal with the brain lesion research that led to the formulation of simultaneous and successive syntheses in cognitive abilities and will provide some empirical evidence for the validity of such conceptualization.

Brain Lesion Research

Studies involving individuals with lesions of the left temporal lobe provide classical evidence that following such excision verbal functions are imparied in the familially right-handed persons. This evidence suggests that verbal functions are in some important sense "located" in the left cerebral hemisphere. Other studies which involved familially right-handed persons with lesions of the right temporal lobe found that nonverbal functions were impaired in these individuals (for a summary of the evidence see Luria, 1973). These and other studies have shown that individuals with lesions of the left temporal lobe manifest disorders of memory and learning on verbal tasks whereas those with right temporal lobe lesions more often show deficit on nonverbal tasks. On tasks involving verbal free recall, recognition memory, and paired associate learning, patients with lesions of the left temporal lobe exhibited selective impairment; however, with memory tasks involving nonverbal stimuli these patients exhibited no impairment. On the other hand, right temporal lobe patients showed selective deficits in delayed reproduction of geometric designs, complex figures and recognition for faces as well as for nonsense figures, but no deficit in analogous verbal memory situations.

On the basis of his clinical and neuro-psychological research and that of others, Luria (1966a, 1966b) proposed a model of information processing and integration. This model proposed simultaneous and successive syntheses as functional properties of the right and the left cerebral hemispheres. Simultaneous synthesis is involved in judgements that require stimuli to

be arranged in a simultaneous manner before making a judgement. This system possesses the property of surveyability and refers to any system of relationships. The successive integration on the other hand deals with sequencing and is not characterized by the property of surveyability possessed in its counterpart. Subjects must arrange stimuli in a serial manner in order to arrive at the target solution in successive processing.

Hardyck (1976) evaluated three models of functional cerebral hemispheric organization (Diamond & Beaumont, 1974; Levie, 1973, 1974; Semmes, 1969) and proposed that hemispheric specialization in humans is organized on a continuum ranging from an organization where each hemisphere is highly specilaized in the sense of being equipped to carry out particular kinds of processing activities within one hemisphere to an organization where each hemisphere has multiple processing capabilities. Hardyck (1976) further emphasized that even in the highly lateralized individual lateralization is far from absolute. "In studies of hemispheric specialization there are no instances where the left hemisphere will complete a task or the right hemisphere was totally unable to respond. Differences in cerebral specialization are a matter of degree, not absolute" (p. 24).

Sperry (1959, 1966, 1967a, 1967b, 1968), Smith (1966, 1969), and Smith and Burklund (1976) have confirmed the view that any complex mental function is affected by the combined activity of both hemispheres, but that each hemisphere makes its own particular contribution to the consturction of mental processes (Ananev, 1952). The notion of a continuum in lateral specialization is manifest in Luria's (1973) account of patients with lesions

of the left inferior parietal (or parieto-temporo-occipital) system. He attributes impairments in such patients in quasi-spatial syntheses such that:

> They have a good understanding of the meaning of individual words, they cannot grasp the meaning of the construction as a whole; they painstakingly attempt to fit the individual elements of the construction together and often declare that constructions incorporating identical words have the same meaning, for they cannot appreciate the meaning of the logico-grammatical relationships expressed by these constructions. It is easy to see that the meaning of construction, such as the sun is lit by the earth or the earth is lit by the sun or a construction in which the word order differs from the order of meaning (for example, "I had breakfast after I had read the newspaper") is completely beyond the grasp of these patients, in that they are completely unable to understand the meaning of more complex constructions such as "Olga is paler than Sonja but darker than Kate". . . . This dissociation between the integrity of intellectual <u>activity</u> and disturbance of intellectual <u>operations</u>, between the integrity of the general <u>purpose</u> and the disturbance of concrete <u>meanings</u>, together with the complete awareness of their own defects, are the features which distinguish this syndrome found in patients with lesions of the parieto-occipital zones of the left hemisphere, leading to the disintegration of simultaneous "quasi-spatial" syntheses. (Luria, 1973, pp. 153-156)

It is evident that the clinical and neuro-psychological evidence of cerebral hemispheric lateralization is very interesting and has provided some unequivocal generalizations in the understanding of brain functions, but the dynamic integration of the two hemispheres in processing complex intellectual tasks is far from being well understood. When further research provides new evidence on the nature and function of the integrational processes, new and exciting educational and practical implications may be expected. On the basis of the evidence presently available on brain functioning some interesting research in cognitive abilities is already underway.

A New Model of Cognitive Abilities

Das (1973) proposed a new model of cognitive abilities based on Luria's (1966a, 1966b) work. He proposed as alternatives to reasoning and memory two modes of information integration, simultaneous and successive, and showed the existence and generality of these two processes by a factor analysis study of the cognitive test scores of nine to eleven year old children from Canada and India. In another factor analytic study, Das and Molloy (1975) found that simultaneous, successive and speed factors existed in each of the grade one and grade four samples. In this particular study, one of the questions considered was whether or not the three factors identified were orthogonal to school achievement. Das (1973) had found that school achievement factor based on tests of reading and mathematics achievement and IQ was "independent" of the other three factors. Again, Das and Molloy (1975) found, to their satisfaction,

that reading achievement emerged as a separate factor with significant loadings on the vocabulary and comprehension subscores of the reading achievement test. In a model that replaces reasoning and memory it is almost unreasonable to be satisfied with a distinct and orthogonal reading factor which is uncorrelated with cognitive functioning involving simultaneous and successive syntheses. One wonders if these factors are not simply an artifact of the factoring method or a result of over factoring. The picture becomes even fuzzier when the final exploratory factor analysis involving the 14 measures of grade four children is considered. This analysis dropped the two reading achievement, vocabulary and comprehension, scores. As a result of this factor analysis, Das and Molloy (1975) identified five factors as successive, simultaneous, socio-economic-status-cultural, speed, and spatial imagery. These factors again appear to be an artifact of the principal component solution and the retention of five factors corresponding to the eigenvalues greater than one. One would think that the simple rule of thumb method of factor extraction might have resulted in the factors which are difficult to explain.

The evidence is convincing that simultaneous and successive processing exhibit individual differences. However, the nature of these processes in terms of other tasks of specific structure and complexity is quite elusive. Even the fact that the factors identified as simultaneous and successive syntheses were uncorrelated with achievement variables (Das, 1973; Das & Molloy, 1975) is puzzling. This is because the

functioning of the two cerebral hemispheres, the basis for the two integrative processes, being unrelated to school performance does not make sense. Why is this so? Perhaps, school achievement and other complex tasks require a dynamic integration of the two processes. Also, the factor analysis procedure used by the previous investigators may not be appropriate for such questions.

The major purpose of the present study is to determine the function of verbal ("successive") and spatial ("simultaneous") abilities in processing information of several structural characteristics.

Method

Subjects

Three hundred twenty-seven 10 year old students in a western Canadian school system comprised the sample.

Testing

The following test battery was given to each child by four testers over a period of two days. All procedures were standardized and instructions given by tape recorders.

Patterns Test

This test consists of 40 shapes each drawn on a 3 x 3 square dot matrix. Each shape had been analyzed for difficulty and item discrimination. The first part of the test, patterns A, consists of the momentary presentation by slide of 20 of the shapes. The subject is required to reproduce the shape immediately after its presentation on a supplied dot matrix. The second part of the test, patterns B, consists of the

presentation of the other 20 shapes but in this instance the subject is required to reproduce on the dot matrix the inverted shape involving a rotation of 180°. From the work of Luria (1966a, 1966b, 1973) and Das (1973) this test would be a measure of the simultaneous synthesis.

Gapadol Test

This test was developed by McLeod and Anderson (1972). Essentially this is a reading ability test based on the Cloze technique which requires students to fill in words randomly omitted from prose material. Both forms, form G and form Y were administered. Because of the requirement of students to link preceding and following words in order to fill in the blank, it was thought these test forms should be measures of the successive synthesis.

Digits-Letters Span

This test was comprised of two parts. The first part of the test consisted of the oral presentation of digits at ½ second and 1 second intervals between digits and the second part consisted of the oral presentation of letters at ½ second and 1 second intervals between letters. The letters and digits were those used in the letter span and digit span of the Kit of Reference Test for Cognitive Factors (French, Ekstrom & Price, 1963). The subject was required to write down the digits in the order in which they had been read. Das, Kirby & Jarman (1975) have shown that this type of test involves successive processing.

Successive-Simultaneous Classification

The test scores were intercorrelated and subjected to a principal

components analysis. Factors with eigenvalues greater than one were rotated to a varimax rotation. The resulting factors are given in Table 1. The resulting varimax three factor structure was used to obtain mathematical factor scores for each of the 327 students. In terms of the design of

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Insert Table 1 about here

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the present study a decision had to be made at this point. Factor III was obviously the simultaneous synthesis factor. For the purpose of the present study it was decided to take Factor II as the successive synthesis factor. A median split of the resulting factor scores using these two factors was then made so that each student was placed in one quadrant of a four-quadrant, two-dimensional model of successive-simultaneous competence.

Obviously Factors I and II involve successive synthesis, given the nature of the tasks defining these factors. The imposed orthogonality on the principal components, however, does not make them structurally or functionally independent. The operationalization of the successive synthesis in the present study is based on tests which rely heavily on reading comprehension and this is consistent with the work of neuro-psychologists (Luria, 1973; Bogen, 1969). Perhaps, these two factors differ in the degree to which they reflect successive integration.

Criterial Tasks

The criterion information processing tasks were administered approxi-

mately two weeks after the initial testing had taken place. These tasks consisted of two each of complexity one to eight bits defined in terms of relevant cues within three structural combinations. The first structural combination, visual-reconstruction (V-R), comprised of a momentary presentation of a slide of a geometric design. This was followed by the second slide containing a number of elements depending upon the complexity (2^n), where n is the complexity. The respondents were required to mark "x" in the spaces on the answer sheet in the presence of the second slide so that their choice(s), at most two, would make the original design. The construction of stimulus materials and the contextual alternatives are explained in Randhawa (1969, 1971, 1972). However, in the present study group testing procedure was used and the materials were adapted for this purpose. An example of a stimulus, the contextual slide, and the response sheet are provided in Figure 1.

Insert Figure 1 about here

The second structural combination, visual-verbal (V-VL), consisted of momentary presentation of a slide of a geometric design which was followed by the second slide as in the V-R tasks. The students were required to place an "x" beside one element of each of the pairs of word cues in the answer booklet so that their choices would enable a person to pick the appropriate elements from the second slide to make the original design. An example of this procedure is provided in Figure 2.

Insert Figure 2 about here

The third structural combination, verbal-reconstruction (VL-R), consisted of a momentary presentation of a vertical list of word cues. The students were then shown the second slide as in tasks V-R and V-VL. In the presence of this second slide the respondents marked an "x" in the spaces corresponding to the elements as required in task V-R so that their choice(s) contained all the properties enumerated in the first slide. An example of this procedure is given in Figure 3.

Insert Figure 3 about here

The 16 tasks within each structural combination were randomized. The three structural sets were presented to a group of students in a school in one of the four random orders. Approximately the same number of students was tested with each of the four orders of structural sets.

Scoring

Each response within a structural set was scored for the number of correct relevant cues (bits) and the average of each of the two tasks at each complexity level was obtained for each respondent.

Design

A 2 x 2 x 2 multivariate and univariate analysis of variance (MANOVA & ANOVA) design was used to analyze the dependent measures in each structural set. The three factors were sex, verbal and spatial with two levels

in each. The total scores for all the usable common items in the three sets were also analyzed in a four-factor ANOVA design with repeated measures on the fourth (structure) factor.

Results and Discussion

V-R Structure

The means of girls on the eight tasks were higher than the boys, but the multivariate F-ratio for the sex effect was only marginally significant /F (8,312) = 1.69, $p < .10$/. The corresponding univariate F-ratios were significant for 3-, 6-, and 8-bit tasks ($p < .05$). The high verbal group was significantly superior to the low verbal group /F (8,312) = 2.65, $p < .01$/. As shown in Table 2, all but two of the corresponding univariate F-ratios were also significant. The significant multivariate F-ratio for the spatial factor /F (8,312) = 1.95, $p < .05$/

Insert Table 2 about here

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indicated, as expected, that the high spatial group was superior to the low spatial group. All but two of the corresponding F-ratios were also significant. No significant interactions were obtained. The lack of interaction between verbal and spatial factors would indicate that these unitary competencies are equally effecitve in processing information in the V-R structure. This would support Paivio's (1971) theory of interactive verbal and nonverbal coding processes. According to this theory each code can be deployed singularly or jointly by the processor depending on

the requirements of the task. In fact, the V-R structure consists of equally easily codable materials in either of the two verbal and nonverbal codes. These findings provide some tentative evidence that successive and simultaneous processes can be considered both parallel and complementary.

V-VL Structure

Within variances and mean vectors for the main effects are provided in Table 3. The multivariate F-ratio for the sex factor was not significant. The multivariate F-ratio for the verbal factor was significant

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Insert Table 3 about here

/$\overline{F}$ (8,312) = 4.44, $p < .01$/ and the corresponding univariate F-ratios were significant for all the tasks except the easiest 1-bit task. The spatial factor was also significant /$\overline{F}$ (8,312) = 2.89, $p < .01$/. The corresponding univariate F-ratios for the spatial factor were significant for 5- to 8-bit tasks. As the tasks become more difficult spatial competence is significantly more effective in processing such tasks.

The multivariate verbal x spatial interaction was significant /$\overline{F}$ (8,312) = 2.04, $p < .05$/. The univariate verbal x spatial interaction was obtained only for 5- and 6-bit tasks. This is obviously due to the

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Insert Table 4 about here

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ceiling effect on the simpler tasks and random guessing, after the channel capacity was reached at the level of discriminating tasks, on the most

difficult tasks. The performance of the four groups appear to have reached asymptotic levels when tasks of 5- and 6-bits were presented. This fact is clearly demonstrated by the channel capacity levels given in Table 4. Also, Table 4 and Figure 4 demonstrate that for such tasks verbal compe-

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Insert Figure 4 about here

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tence generally provides differential advantage depending upon the spatial competence. Randhawa (1969, 1971, 1972) on the basis of developmental studies concluded that language competence plays a predominant part in the description of perceptual patterns. The present evidence from the individual differences perspective confirms the role of language competence in tasks involving verbal transformation. Hunt, Randhawa, and Fitzgerald (1976) also found some evidence for such a differential advantage in rote and semantic short-term retention as verbal (successive) competency increased. They also found evidence for an interactive spatial and verbal competency involved in long-term retention.

VL-R Structure

Scores for the 4- and 5- bit tasks were excluded from this analysis because the slides for these tasks in two of the four random orders of sets were found to be incorrectly placed in the trays and did not correspond with the answer sheet. After this error was discovered, these tasks were omitted in subsequent testing.

The sex factor was significant /F (6,314) = 3.08, $p < .01$/. This result coupled with the examination of the mean vectors (see Table 5) for

the boys and the girls indicated that girls were generally superior to boys in processing the VL-R tasks. McGlone (1976) suggests that a greater

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Insert Table 5 about here

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degree of brain functional and structural asymmetry is found in men than in women. However, developmental studies indicate that girls show earlier and stronger lateralization of speech, motor, and sense functions compared to boys. Left hemisphere dominance may in fact establish itself sooner in females, a maturational advantage which fits well with their reported superiority to males on certain speech related tasks. Ultimately, however, adult females appear to be less lateralized than males for verbal and spatial functions. Maturational and interhemispheric integration differences in the boys and the girls in the present population might account for the sex differences.

The overall verbal factor /$\overline{F}$ (6,314) = 5.35, $p < .01$/ and the spatial factor /$\overline{F}$ (6,314) = 2.47, $p < .05$/ were significant. Within variance and means on these main effects are provided in Table 5. All the corresponding univariate F-ratios on the verbal factor were significant. All but two of the corresponding univariate F-ratios were significant on the spatial factor. As expected either of the two advantages were effective in processing VL-R tasks. However, the verbal x spatial interaction /$\overline{F}$ (6,314) = 3.68, $p < .01$/ indicate that children with superior verbal competence had differential advantage over those with inferior verbal

competence depending upon their spatial competence. Combined means for

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Insert Table 6 about here

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this interaction are given in Table 6. Figure 5 provides an illustration for this phenomenon. The critical univariate interaction was for task of 6-bit complexity. This task, as in V-VL structure, provided the asymptotic and discriminative performance of the groups. Besides the interpretation that verbal competence provides differential advantage this

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Insert Figure 5 about here

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result may be interpreted in terms of cerebral interhemispheric integration. As pointed out earlier, two hemispheres become specialized, to some extent, for verbal and spatial tasks and it is essential that the two competencies be developed for the interhemispheric interrelation to take place.

Univariate Repeated Measures ANOVA

Total scores on the 12 tasks (excluding 4- and 5-bit tasks) were analyzed in the univariate repeated measures ANOVA with the explicit purpose of testing the equality of the means of the totals. Significant differences among these means as well as the pair-wise differences were expected. As expected the within factor was significant /$\overline{F}$ (2,639) = 400.58, $p < .0001$/. Also, the three pair-wise tests of effects were significant ($p < .05$). The observed means on V-R, V-VL, and VL-R were 47.61,

28.93, and 32.41 respectively which clearly suggest that V-R was the easiest and the V-VL the most difficult structure. Verbal coding of perceptual information seems to pose more difficulty for the subjects than the non-verbal coding of verbal attributes of perceptual information. In developmental studies, Randhawa (1969, 1971, 1972) posits similar explanation for the differences in processing information involving four structural types. Five, 8-, and 12-year old children consistently found the structures increase in difficulty as demands on verbal coding increased.

General Discussion

It is clear that the successive/simultaneous synthesis model springs from a conceptualization of the cerebral lateralization of the two hemispheres of the brain. A proper operationalization of this model should be based on theoretically and educationally relevant tasks.

Luria's conceptualization of the brain functions and the dynamic integration between the two hemispheres is promising. The present knowledge of clinical and neuro-psychological evidence points out that besides the functional independence between the successive and simultaneous syntheses an interactive process is operative in the integration of the two hemispheres of the brain in processing tasks that require the simultaneous action of the two cerebral hemispheres. Task specific behaviors of a variety of individuals in the normal population range should be studied to determine whether an individual uses simultaneous, successive, or both in coping with the demands of the task. Then these individual dispositions on specific tasks be used in determining their appropriateness for instructional tasks ranging

in nature from simple to complex. It is conceivable that different individuals might employ different syntheses for the same task depending on their preferences, prior learning history and general cognitive orientation. An important concern in instructional planning for normal and exceptional children is to know beforehand in a macroscopic sense what specific strategies are most suitable for a given task, given the available instructional resources. A beginning in this context can be made with tests, instruments, and tasks that already exist and the nature of which in terms of cognitive demands is already well known. Of course that should not limit those with creative drive to develop new measures for the classification of individuals as habitually successive, simultaneous or dual modal processors. The stability of cognitive preferences and the endurance of such preferences over a range of tasks is an issue that is far from resolved. Generalizability of stylistic preferences across different domains requires a careful and systematic study.

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Table 1

Varimax Factor Loadings for the

Patterns, Gapadol and Digit-Letters Tests (N=327)

Variable	Factor Loadings[1]			
	1	2	3	h^2
Gapadol G	17	93	07	90
Gapadol Y	16	94	08	91
Patterns A	12	-01	89	80
Patterns B	09	16	87	79
Digit (½ sec.)	73	26	05	60
Digit (1 sec.)	83	-02	07	69
Letters (½ sec.)	63	29	16	50
Letters (1 sec.)	73	06	08	55

[1]Decimals omitted

Table 2

Within Variance and Means on the Main

Effects for the V-R Tasks

Task	Within	Successive (Verbal)		Simultaneous (Spatial)		Sex	
(Bits)	Variance	Low(159)	High(168)	Low(164)	High(163)	Male(169)	Female(158)[a]
1	0.04	0.91*	0.96	0.90*	0.96	0.93	0.94
2	0.11	1.63	1.69	1.62*	1.67	1.65	1.67
3	0.19	2.74*	2.91	2.77*	2.88	2.77*	2.88
4	0.53	3.52*	3.79	3.62	3.70	3.59	3.73
5	0.70	4.34*	4.68	4.38*	4.65	4.48	4.56
6	1.07	5.16*	5.49	5.26	5.41	5.19*	5.49
7	1.40	6.20	6.45	6.19*	6.47	6.21	6.46
8	2.18	6.47*	6.97	6.53*	6.93	6.48*	7.00
Average	0.36	3.87*	4.12	3.91*	4.09	3.91*	4.09

*Significant at the .05 level.

[a]Numbers in parentheses indicate the number of children in each subgroup.

Table 3

Within Variance and Means on the Main

Effects for the V-VL Tasks

Task	Within	Successive		Simultaneous		Sex	
(Bits)	Variance	Low	High	Low	High	Male	Female
1	0.08	0.90	0.90	0.91	0.89	0.88	0.92
2	0.27	1.39*	1.61	1.46	1.54	1.43*	1.58
3	0.59	2.03*	2.30	2.12	2.22	2.12	2.21
4	0.98	2.68*	3.06	2.78	2.96	2.79	2.96
5	1.94	2.76*	3.13	2.67*	3.23	2.84	3.06
6	1.62	2.98*	3.37	2.99*	3.36	3.04*	3.32
7	3.07	2.55*	3.51	2.68*	3.40	3.04	3.04
8	2.93	3.37*	4.05	3.51*	3.92	3.53*	3.92
Average	0.53	2.33*	2.74	2.39*	2.69	2.46*	2.63

*Significant at the .05 level.

Table 4

Combined Means on Successive x Simultaneous

Interaction for the V-VL Tasks

Task	Group			
(Bits)	Lo-Lo (79)	Lo-Hi (80)	Hi-Lo (85)	Hi-Hi (83)[a]
1	0.91	0.88	0.90	0.90
2	1.38	1.40	1.54	1.68
3	2.01	2.06	2.22	2.37
4	2.68	2.67	2.87	3.24
5	2.75*	2.77	2.60	3.67
6	2.96*	3.00	3.03	3.72
7	2.31	2.79	3.04	3.99
8	3.23	3.51	3.77	4.33
Average	2.28*	2.38	2.49	2.99

*Significant at the .05 level.

[a]Numbers in parentehses indicate the number of children in each subgroup.

Table 5

Within Variance and Means on the Main

Effects for the VL-R Tasks

Task	Within	Successive		Simultaneous		Sex	
(Bits)	Variance	Low	High	Low	High	Male	Female
1	0.01	0.97*	1.00	0.98*	1.00	0.98	0.99
2	0.06	1.90*	1.97	1.91*	1.96	1.90*	1.97
3	0.32	2.61*	2.80	2.63*	2.78	2.61*	2.81
6	1.70	3.17*	3.92	3.46	3.65	3.36*	3.76
7	2.64	2.96*	3.67	3.24	3.41	3.13*	3.53
8	3.13	3.02*	3.79	3.21*	3.62	3.32	3.51
Average	0.23	1.83*	2.14	1.93*	2.05	1.91*	2.07

*Significant at the .05 level.

Table 6

Combined Means on Successive x Simultaneous

Interaction for the VL-R Tasks

Task	Group			
(Bits)	Lo-Lo	Lo-Hi	Hi-Lo	Hi-Hi
1	0.95*	1.00	1.00	1.00
2	1.84	1.95	1.97	1.97
3	2.55	2.68	2.71	2.88
6	3.27*	3.07	3.64	4.20
7	2.97	2.95	3.49	3.85
8	2.97	3.07	3.43	4.15
Average	1.82*	1.84	2.03	2.26

*Significant at the .05 level.

Figure Captions

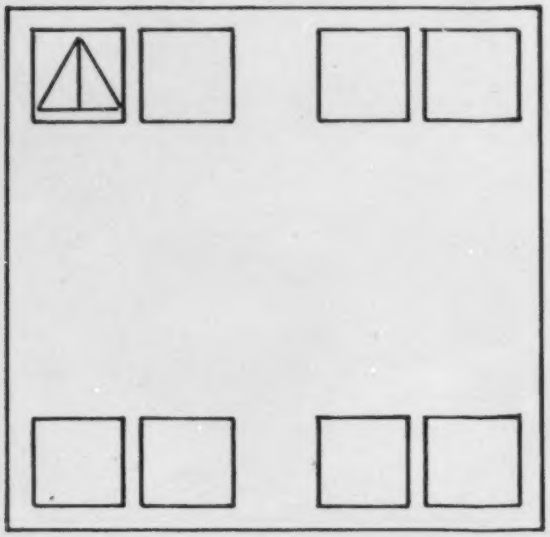
Figure 1. An example of a visual-reconstruction (V-R) task of 5-bit complexity. a) The stimulus slide, b) the contextual slide, and c) the response sheet.

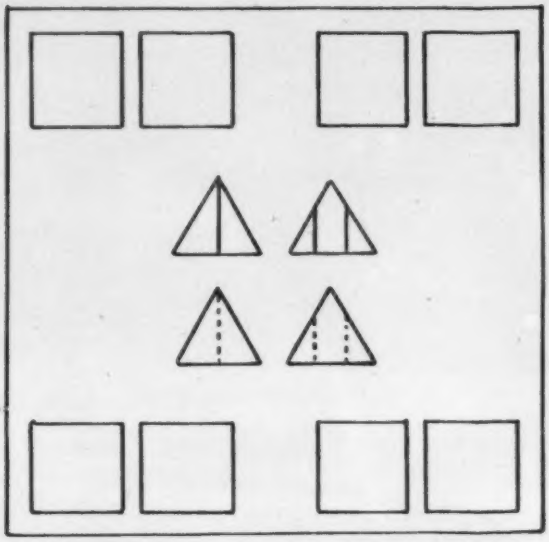
Figure 2. An example of a visual-verbal (V-VL) task of 5-bit complexity. a) The stimulus slide, b) the contextual slide, and c) the response sheet.

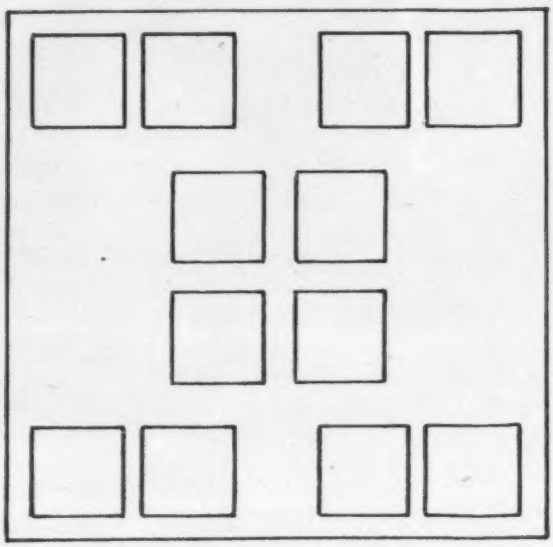
Figure 3. An example of a verbal-reconstruction (VL-R) task of 2-bit complexity. a) The stimulus slide, b) the contextual slide, and c) the response sheet.

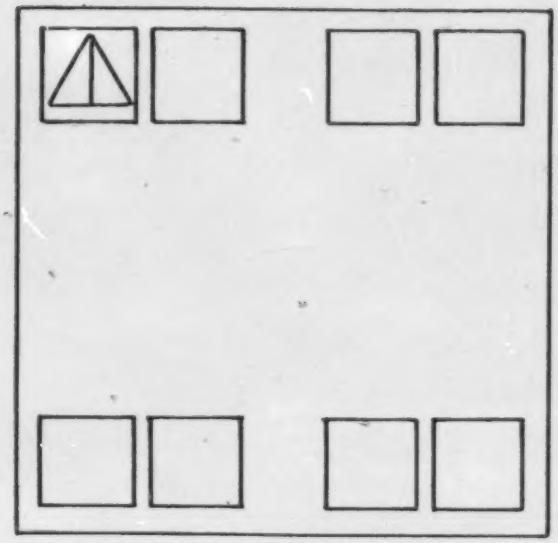
Figure 4. An illustrative verbal x spatial interaction on the average score in the V-VL structure.

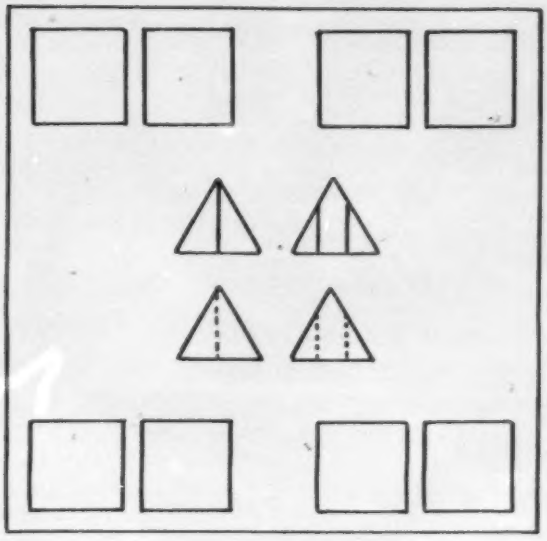
Figure 5. An illustrative verbal x spatial interaction on the average score in the VL-R structure.











LEFT _____ ONE _____

RIGHT _____ TWO _____

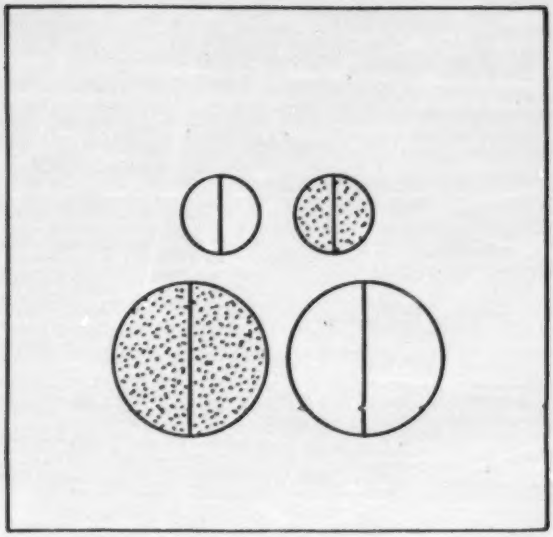
TOP _____ SOLID _____

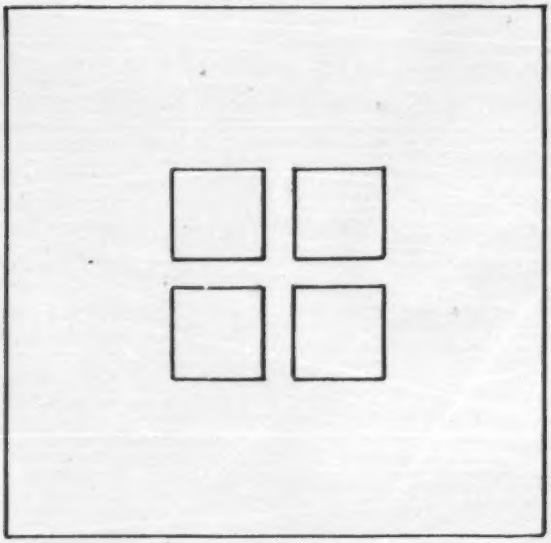
BOTTOM _____ DOTTED _____

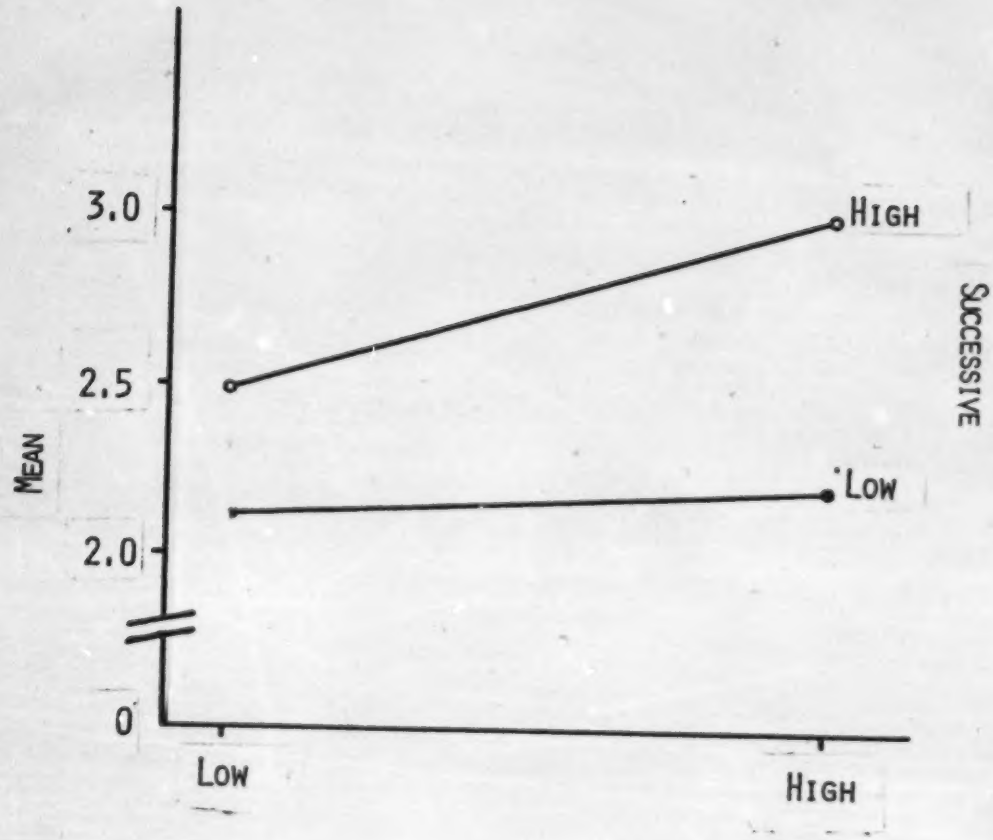
YELLOW _____

BLUE _____

RED
SMALL



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2.0
0
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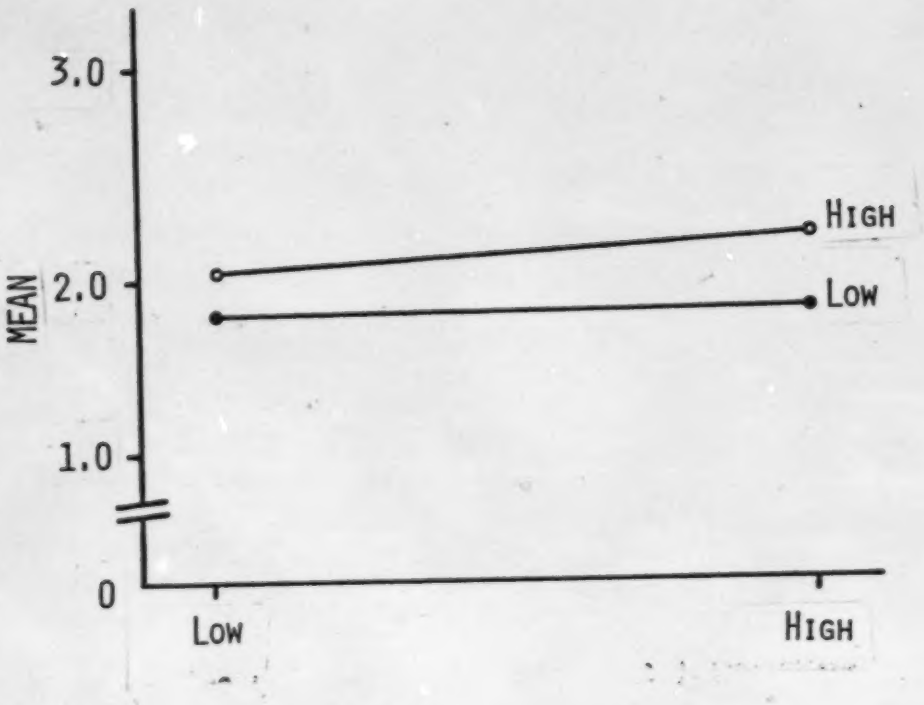
HIGH
LOW
SUCCESSIVE
LOW
HIGH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MEAN
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LOW
LOW
HIGH